CLAIMS:

1. A method of imaging a sample, the method comprising the steps of :

(a) irradiating the sample to be imaged with an irradiating beam of pulsed electro magnetic radiation with a plurality of frequencies in the range from 25 GHz to 100 THz,

(b) detecting both the radiation transmitted through the sample and the radiation reflected by the sample;

(c) generating an image of the sample from the radiation detected in step (b).

2. A method according to claim 1, wherein step (c) comprises the step of calculating the time of flight of a pulse transmitted through the sample; calculating the time of flight of a pulse reflected from an interface or surface of the sample; and plotting the difference or function of the difference of the time of flight of the transmitted and reflected pulse relative to the time of flight of the reflected pulse.

3. A method according to either of claims 1 or 2, wherein step (c) further comprises the steps of extracting the parts of the transmitted pulse which are due to an even number of reflections within the sample, and determining the position of an interface using the signal caused by said even number of reflections.

4. A method according to any preceding claim, further comprising the step of detecting a reference signal obtained from an object having a known separation from either the emitter of irradiating beam or the sample to be imaged.

5. A method according to claim 4, wherein the reference signal is obtained from a reflection off a component of the emitter.

6. A method according to any preceding claim, wherein the irradiating beam has a beam diameter smaller than that of the smallest wavelength of the radiation of the beam.

7. A method according to any preceding claim, wherein the irradiating beam is emitted by an emitter, the emitter being irradiated with at least one input beam of radiation with frequencies in the visible or near infra red frequency range, the emitter being a material with non-linear optical properties

8. A method according to claim 4, wherein the input beam has a beam diameter which is smaller than the smallest wavelength of the beam of pulsed radiation of step (a).

9. A method according to either of claims 7 or 8, wherein the emitter is a semiconductor.

10. A method according to any of claims 1 to 8, wherein the material with non-linear optical properties is chosen from the group of $LiIO_3$, $NH_4H_2PO_4$, ADP, KH_2PO_4, KH_2ASO_4, Quartz, $AlPO_4$, ZnO, CdS, GaP, GaAs, $BaTiO_3$, $LiTaO_3$, $LiNbO_3$, Te, Se, ZnTe, ZnSe, $Ba_2NaNb_5O_{15}$, $AgAsS_3$, proustite, CdSe, $CdGeAs_2$, $AgGaSe_2$, $AgSbS_3$, ZnS, DAST (4-N-methylstilbazolium) or Si.

11. A method according to any of claims 7 to 10, where the sample is mounted such that there are no active optical components between the sample and the emitter.

12. A method according to any of claims 7 to 11, wherein the emitter is configured to hold the sample.

13. A method according to any of claims 7 to 12, wherein the sample is positioned with a separation from 10 μm to 500 μm from the emitter.

14. A method according to any of claims 7 to 13, wherein the emitter is of a size such that radiation reflected from the sample can pass back through the emitter.

15. A method according to any of claims 7 to 14, wherein the emitter is substantially transparent to the irradiating beam.

16. A method according to any of claims 7 to 15, wherein the emitter is mounted on a material which is transparent to the irradiating beam.

17. A method according to any preceding claim, wherein the sample is mounted on a material which is transparent to the irradiating beam.

18. A method according to any preceding claim, wherein in step (b), an area of the sample which is to be imaged is subdivided into a two-dimensional array of pixels, and radiation is detected from each pixel.

19. A method according to claim 18, wherein the sample is moved, such that the transmitted and reflected radiation can be detected pixel by pixel.

20. A method according to claim 19, wherein both the sample and the emitter are moved, such that the reflected and transmitted radiation can be detected pixel by pixel.

21. A method according to any preceding claim, wherein a CCD camera is used to detect the radiation reflected from the sample.

22. A method according to any preceding claim, wherein a CCD camera is used to detect the radiation transmitted through the sample.

23. A method according to any preceding claim, wherein a three dimensional image is generated in step (c).

24. A method according to any preceding claim wherein a compositional image is generated in step (c).

25. An apparatus for imaging a sample, the apparatus comprising:-

a) means for irradiating a sample to be imaged with an irradiating beam of pulsed electromagnetic radiation with a plurality of frequencies in the range from 25GHz to 100THz;

b) means for detecting radiation which is both transmitted through and reflected from the sample; and

c) means for generating an image of the sample from radiation detected in step (b).

26. An apparatus according to claim 25, wherein the means for generating an image comprise means for calculating the time of flight of a pulse of radiation transmitted through the sample, means for calculating the time of flight of a pulse of radiation reflected from an interface or surface of the sample; and means for plotting the difference or a function of the difference in the time of flight of the transmitted and reflected pulse relative to the time of flight of the reflected pulse.

27. An apparatus according to either of claims 25 or 26, wherein the means for generating an image of the sample comprise means for extracting the parts of the transmitted pulse which are due to an even number of reflections within the sample, and determining the position of an interface using the signal caused by said even number of reflections.

28. An apparatus according to any of claims 25 to 27, further comprising means for generating a reference signal.

29. An apparatus according to claim 28, wherein the means for generating a reference signal comprise means for measuring a signal reflected from a component of the means for irradiating the sample.

30. An apparatus according any of claims 25 to 29, wherein the means for irradiating a sample, comprises an emitter for emitting the irradiating beam, the emitter having optical non-linear properties, such that when the emitter is irradiated with an input beam with a frequency in the visible or near infra-red frequency ranges, a beam is emitted with frequencies in the range from 25GHz to 100THz.

31. An apparatus according to claim 30, wherein the input beam of pulsed radiation has a diameter which is smaller than that of the smallest wavelength of the irradiating beam.

32. An apparatus according to any of claims 25 to 31, wherein the apparatus further comprises a motorised stage, configured so that it can be stepped pixel by pixel in two orthogonal directions.

33. An apparatus according to claim 32, wherein the sample is mounted on the motorised stage.

34. An apparatus according to claim 33 when dependent on claim 30, wherein both the sample and the emitter are mounted on the motorised stage.

35. An apparatus according to claim 33, when dependent on claim 30, wherein the emitter is mounted on a material which is transparent to the irradiating beam.

36. An apparatus according to claim 35, wherein the area of the emitter which faces the sample is 25mm x 25mm or less.

37. An apparatus according to either of claims 35 or 36 when dependent on claim 25, wherein the sample is moveable relative to the emitter.

38. An apparatus according to any of claims 25 to 37, wherein the means for detecting the radiation comprises a CCD camera for detecting the reflected radiation.

39. An apparatus according to any of claims 25 to 38, wherein the means for detecting the radiation comprises a CCD camera for detecting the transmitted radiation.

40. An apparatus according to any of claims 25 to 39, wherein the means for generating an image of the sample comprises means for generating a three dimensional image of the sample.

41. An apparatus according to any of claims 25 to 40, wherein the means for generating an image of the sample comprising means for generating a compositional image of the sample.

42. A method as substantially hereinbefore described with reference to the accompanying drawings.

43. An apparatus as substantially hereinbefore described with reference to the accompanying drawings.

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